fits our plant very well. The type appears to have been founded on a glabrous Mexican plant, and the var. *pubescens* subsequently established as one of Chas. Wright's No. 825 from New Mexico. I have it from Mr. Baker that one of the specimens included under Chas. Wright's 825 agrees with Mr. Pringle's 461, and also with Rusby's plant from New Mexico, from which it is evident that a portion of Wright's 825 was not true *flexuosa.*

In the absence of more convincing evidence to the contrary, therefore, it seems best to restore Mettenius' species and refer to it this plant of Mr. Pringle's which answers to the var. *pubescens.* Specimens collected in New Mexico by Rusby and in Arizona by Lemmon, and distributed as *P. cordata* or as *P. Andromedæfolia*, var. *pubescens*, must also be so referred. The *P. cordata* of my Catalogue Supplement and Check Lists thus becomes *Pellæa intermedia*, Mett.

440—*Pellæa pulchella*, Fée. Limestone ledges, Santa Eulalia Mts.; March.

446.—*Pellæa ternifolia*, Link. Grassy summits, Santa Eulalia Mts.; November.

443—*Polypodium thysanolepis*, A. Br. Cold cliffs, rocky hills; October.

445—*Woodsia Mexicana*, Fée. Wet ledges; October.

450—*Psilotum complanatum*, Spring. Seams of rocky hills; October.

EXPLANATION OF PLATE.

1, plant. 2, a lower pinna. 3, a middle pinna. 4, an upper pinna. 5, a lobed segment with section rolled back showing sori. 6, scale from base of stipes.

The Nectary of Yucca.

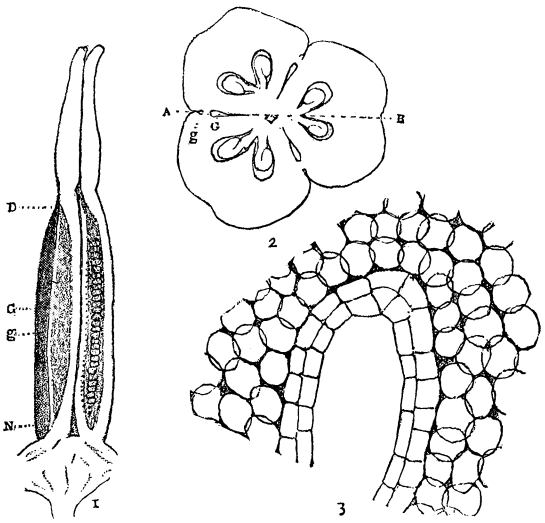
By WILLIAM TRELEASE.

The curious facts connected with the pollination of the capsular Yuccas discovered by Englemann and Riley* have attracted much attention and elicited a good deal of criticism, in most cases undeserved. So far as I have observed, none of this has applied

*Engelmann: BULL. TORREY BOT. CLUB, iii., 33, 37; iv., 63. Riley: Trans. St. Louis Academy, iii., 55, 178, etc.

to the behavior of the Yucca moth (*Tegeticula Yuccasella*, Riley), while in the flowers, but mainly to the necessity for its intervention in their fructification.

Since reading his articles, I have had a suspicion that Professor Riley must have been mistaken in his belief that the stigmatic cavity is nectariferous,* as I know of no instance in which a liliaceous flower possesses a stigmatic nectary. But it was not until the present spring that I had an opportunity to give the flowers a careful examination. I then found, as I had expected, that the stigmatic tube contains no secretion aside from that which is customary to organs of this character, namely the slight amount of moisture, of a more or less gummy nature, that apparently serves as a stimulus to the nascent pollen-tubes.



In *Yucca*, as in many other Liliaceæ and related endogens, the nectar glands (G, figs. 1 and 2) occur within the partitions that separate the three cells of the pistil, forming thin pockets extending nearly from the base to the summit of the ovary. These pockets are entirely closed except at the top, where they open externally by a contracted pore (D, fig. 1). Nevertheless, they represent superficial structures, since they occur within the suture corresponding to the external (dorsal) surfaces of the

* Trans. St. Louis Acad., iii., 59, 60.

carpels which constitute the compound pistil. They are lined by a double series of flat pavement-cells (fig. 3) homologous with the external epidermis. It is these closely set flat cells—very different from the round, loosely connected cells of the surrounding pulp—which constitute the secreting tissue or gland proper.

Brongniart,* who studied this class of glands very thoroughly, could find no external opening to these of *Yucca*, although *Y. gloriosa* is included in his list.† He was, therefore, of the opinion that they must communicate with a narrow canal which runs between the carpels from base to summit, and which, as Riley has stated, and as I have attempted to show in figure 1, passes above into the stigmatic cavity, into which the three cells of the ovary open by narrow but unmistakable passages. Such stylar or intrastylar canals communicating with the ovary are not infrequent in the vegetable kingdom,‡ the loose, more or less deliquescent cells which line them replacing the conducting tissue of such plants as have a solid style, in the guidance and nutrition of the pollen tubes.

Another point which misled Brongniart was the failure to detect nectar about the pistil, as in *Allium*, *Hyacinthus* and other genera. The reason for this appears to be twofold. The amount of secretion under the most favorable circumstances in *Yucca filamentosa*, to which my remarks apply, is very small, nor is it discharged externally at the point D, where the gland opens, but, as may be seen from a comparison of figures 1 and 2, it is poured at this point into a capillary tube (g), enclosed by the closely applied but not outwardly united lobes of the ovary, in which it flows downward to a point (N, fig. 1) at the base of the pistil, where the tube widens slightly into a contracted triangular pore, opposite the base of a petal, and discharges the scanty supply of fluid, which I have never seen more than filling it, while in many cases this opening is not even perceptibly moistened.

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*Mémoire sur les glandes nectarifères de l'ovaire—Ann. des Sci. nat., 4th Ser., ii. See also Grassmann : Die Septaldrüsen.—Flora, 1884, Nos. 7-8 ; and abstract in Bot. Centralblatt, xix., 5.

† Pp. 5-6 of reprint.

‡ See Behrens : Untersuchungen über den anatomischen Bau des Griffels und der Narbe. Inaugural Dissertation, Göttingen, 1875.

The structure, as I have described it, agrees with the generalization of Grassmann * for all Liliaceæ with septal glands, except *Allium*, where the original opening of the gland is lower, but otherwise similar. It can be made out by careful longitudinal sections like that figured, or even better by breaking the fresh ovary lengthwise between two carpels, when the full length of the gland is easily laid open. I have also convinced myself that there is no connection with either the ovarian cells, the intrastylar canal or the stigmatic cavity that prolongs them both, by cutting serial cross-sections of the ovary like that represented in figure 2, through the entire length of the pistil, repeating them many times at the critical points, namely, the top and bottom.

There is a more or less prevalent opinion that the glands of plants and animals differ in the superficial character and greater simplicity of the former; excepting, of course, those internal resin and oil passages which do not open for the liberation of their secretion—*e. g.*, the resin passages of Coniferæ and the oil receptacles of the orange, mints, etc. It is true that the number of vegetable glands which are situated within the plant but discharge their secretion at the surface through a duct-like opening is small, as I endeavored to show in an unpublished communication to the Boston Society of Natural History a number of years ago; but they are occasionally met with. The follicles at the mouth of *Nepenthes* pitchers, described, I believe, by Mr. Potts in the Proceedings of the Philadelphia Academy, some years since, are the simplest type of this sort of structures, to which also belong the protective nectar glands on the peduncles of the Cow Pea (*Dolichos* sp.), which I figured in the American Bee Journal, in 1880; and presumably in the similar organs of species of *Apios* and *Phaseolus*. These latter organs, which correspond to abortive flower buds, are very complex and will well repay a careful study of their developmental history.

The nearest approach to such lobulated glands of animals as the salivary glands is, however, found in the ovarian glands of the endogens. In some cases † these are produced into contracted

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*See Bot. Centralblatt, 1884; xix., 6-7.

†*E. g.*, *Strelitzia*, as figured by Brongniart, l. c., pl. 4, f. 3.

and much elongated ducts, while in others* their secreting surface is increased by a more or less sinuous development, resulting in prominent longitudinal folds in the last two genera referred to, and other epigynous Bromeliaceæ, where the three glands are also, for a part of their extent, confluent, merging into the intra-carpellary cavity, although they do not appear to discharge through this at the stigma, their ducts offering a freer exit for the nectar into the base of the flower.

The glands of *Yucca* play a very unimportant part in the pollination of the flowers, a fact which apparently explains the partial loss of secreting power, and is unquestionably connected with their adaptation to the good services of the Yucca-moth. In watching a good many of these insects at night, while engaged in pollinating the flowers and depositing their eggs, I saw only a single one attempt to feed, and this tried to probe the three glands of a flower at the point D, where the glands open into the conducting grooves. Whether it succeeded in penetrating into the latter or not could not be seen. It remained at each gland not over two or three seconds, and on leaving the flower was captured and proved to be a male. During the day the moths of both sexes, as well as the bogus Yucca-moth (*Prodoxus*), remain in the flowers, commonly standing on the filaments with their heads at the bottom of the corolla. My impression is that they feed at this time; but the disturbance necessitated by opening the partly closed flowers is sufficient to cause them to stop, if this is true, and I have, in point of fact, never seen them thus engaged.

I was not able to see the insects engaged in collecting pollen, but there is no reason to doubt the entire accuracy of Professor Riley's statement‡ that the females deliberately go to the stamens and accumulate a supply of pollen on their remarkable spinose tentacles, before beginning the work of pollination and oviposition. While engaged in this work, as he has stated, they will bear the full blaze of a lantern in the flower, and may even be watched through a lens without desisting, though, if the light is too suddenly turned

*_Strelitzia_, l. c., pl. 4, f. 6; _Melinonia_, l. c., pl. 3, f. 1-4; _Billbergia_, l. c., f. 6-10.

‡ Amer. Naturalist, xvi, (1882), pp. 62, 63.

upon them or if the plant is jarred, they sometimes remain quiet for a time or hurriedly scuttle out of the flower and take wing. I can corroborate in every important detail the account given by Riley of the method of oviposition and pollination, either of which may occur first, while in a given flower both are usually repeated many times before the moth goes to a new one. The energetic manner in which the little insect works its head up and down while depositing pollen in the stigmatic cavity, is very interesting, and cannot fail to convince a person who sees it that there is as much object in its work as in the nest-building of birds, or other so-called instinctive operations of the lower vertebates. To more effectually accomplish its mission, the moth usually pushes the pollen further into the cavity than its tentacles can reach, using its tongue for this purpose, and it is perhaps this action which led Riley to believe that it sips nectar from the stigma while engaged in the act of pollination. Once a pair of moths were seen to copulate in the flower, the union not lasting more than three or four seconds, the female actively running about the flower in the meantime, and immediately resuming the labor of oviposition on its completion, when the male flew to another flower.

If what I have observed may serve to disprove any positive value of their nectar in the pollination of *Yucca* flowers, it only adds to the general interest of the subject; for it shows that not only the act of collecting the pollen is performed voluntarily and without any food compensation, as stated by Riley, but also that of transferring it to the stigma—a case without a parallel, so far as I know, among entomophilous flowers, if we exclude those with false nectaries; and I doubt if these are all fully understood.

The student who wishes to look up the literature of the pollination of *Yucca*, will find an indication of the principal papers on the subject in Thompson's catalogue of books and papers relating to the fertilization of flowers, in the English edition of Müller's Fertilization of Flowers, to which should be added: Meehan, Penn Monthly, 1876, 836; Bot. Gazette, iv., 242; Proc. Phila. Acad., 1880, 355; Amer. Agriculturist, 1872, 461; 1873, 223; Müller, Wechselbeziehungen, 39; Darwin, Cross and

Self-Fertilization, 418; Gard. Chron., Jan., 1880, 81; July, 1880, 110. Other references occur in the additional papers to which I have already referred, as well as in many of these.

EXPLANATION OF FIGURES.

1. Longitudinal section of the ovary of *Yucca filamentosa*, on the line A—B of the next figure, ×2.

2. Cross section of the same, at about the middle, ×6.

3. A portion of 2, at G, ×200.

G, the nectar gland, opening at D into g, the conducting groove into which its secretion is poured and in which it passes to N, where it appears at the outside of the ovary.

Since the foregoing was written I have had an opportunity to observe *Y. angustifolia* in full bloom in the Ute Pass, north of Manitou, Col. The nectar glands of this species are about as in *Y. filamentosa*, and open and discharge their secretion similarly, but I have found the latter rather more abundant. The stigma of *Y. angustifolia* is rather larger, and very green, as contrasted with the white stigma of *Y. filamentosa*, and its secretion is more abundant, so that frequently a prominent drop is visible between its lobes. The pistil differs in that the stigmatic cavity is short aud does not communicate with the ovarian cells, so far as can be seen with a three-fourth lens.

One or more species of *Pronuba* and *Prodorus* are met with in the flowers in considerable numbers. The opportunity has not offered for watching the former at night; but many of the flowers are pollinated, the abundant white pollen contrasting so strongly with the dark green stigma as to render its presence evident even to the naked eye. Scattering dried capsules on the stalks of last year and an abundant crop of this year's fruit attest the efficacy of this pollination, which could only have been effected by the moths in the flowers I refer to.

JULY 19, 1886.

Some Californian Polypetalæ.

BY E. L. GREENE..

STREPTANTHUS NIGER.—1 to 3 feet high, paniculately branching from near the base, glabrous and glaucous; leaves linear, 2 to 3 inches long, the lowest with narrow, divaricate,